Trees Prepare For Winter

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It's a question many of us have pondered at one time or another as we witness the transformation of green forests into bright bursts of orange, red and yellow...why exactly do leaves change color? What's happening physiologically?

Every autumn, deciduous trees go through a series of steps in preparation for winter. Deciduous trees are those that annually shed their leaves; this includes most broadleaf trees in the U.S. and one conifer (the larch, or tamarack). The process is triggered by both internal hormonal activity and temperature, day length, light quality (sun angle) and water supply.

As autumn sets in, the trees stop producing chlorophyll, the green-pigmented photosynthetic material in leaves. At the same time, species that contain large amounts of carbohydrates begin to form anthocyanins (a red-colored pigment) in their leaves. As chlorophyll synthesis stops, the chlorophyll already present begins to disintegrate and the newly formed anthocyanins are unmasked.

In trees that do not form anthocyanin pigments, the chlorophyll breakdown unmasks the already existing yellow to orange carotene and xanthophyll pigments, resulting in yellow-colored leaves. Thus, by disintegration of green pigments; the unmasking of yellow pigments; or the formation of red pigments; or all three, the leaves may assume various shades of yellow, orange, crimson, purple or red.

Trees such as alder and black locust show little color change. A large group of trees, including black walnut, catalpa, elm, hickory, basswood and sycamore turn to a mixture of rusty green and yellow. Leaves of aspens (poplars), honey locust, gingko, beech and most birch species turn a brilliant yellow.

The dazzling reds of autumn are the leaves of sugar and red maples, and white and scarlet oak. Within these species a wide spectrum of color can develop depending on environmental conditions and carbohydrate concentrations.

The lowering of temperatures to near freezing favors anthocyanin formation, while severe early frosts make red autumn colors less brilliant. Bright light favors red colors. Droughty conditions also favor bright red colors, and rainy, cloudy fall days decrease the intensity of fall colors. In short, the best colors occur under conditions of clear, dry and cool but not freezing weather.

Leaf senescence and abscission

Leaf senescence (death) and abscission (falling off) follow color change. Adverse environmental conditions, such as short days and temperature change, also serve as triggers for these processes. Senescence is associated with color change and involves the loss of chlorophyll and the export of carbohydrates, nitrogen and minerals from the leaves back into the tree. In effect, trees conserve resources by sucking all of the reusable materials from the leaves before they fall off.

Leaf drop, or abscission, is under strong hormonal control. The hormone auxin works throughout the growing season to prevent abscission. In the fall, hormonal ethylene increases in concentration relative to auxins and triggers abscission.

Cold hardiness

Trees go through three sequential stages of acclimation to cold. The first stage is set in motion by decreasing the day length in autumn, and involves the cessation

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of growth and changes in metabolism that condition the tree to respond to low temperatures.

The second phase of acclimation is induced by freezing or near-freezing temperatures. During this stage, changes occur in sugars, proteins, amino acids, nucleic acids and organic acids, and the tree develops resistance to freezing.

The third stage is triggered by very low temperatures (-20 degrees to –60 degrees F). In this stage, trees can withstand very deep freezes (some down to –430 degrees F). This final phase of acclimation appears to be largely a physical process involving the binding of water. Water in cells is bound so tightly that it resists dehydration and reduces the amount of water available for destructive crystallization. Any unbound water would freeze, expand and destroy the water-conducting vesicles and tracheids, like frozen water would shatter a glass bottle.

The trees also employ supercooling to prevent frost damage. By increasing the sugar and other solute concentration of their sap, the freezing point is reduced so low that only unusually cold conditions can cause the sap to freeze.

Dormancy in trees

Dormancy is also an adaptive strategy employed by trees in temperate regions to survive harsh winters. Dormancy is brought on by the same triggers that induce leaf color change, senescence, abscission and cold hardening.

When seasonal shoot growth ceases, the trees first enter a phase of inactivity called quiescence. This is a mild dormancy that can be broken by increased temperatures or more favorable lighting. As autumn continues and temperatures continue to drop, the state of dormancy deepens until true dormancy is attained and shoot tips can no longer break dormancy and elongate, even under the most favorable conditions. This deep dormancy can only be broken after a certain length of cold weather, or cooling period. This genetically controlled cooling period prevents trees from breaking dormancy on a warm January day and exposing tender new shoots to killing frosts. The trees will only break dormancy when the danger of deep frosts is over or at least minimized.

To protect the delicate, dormant growing tissue from winter damage, trees "set" a terminal bud at the end of each growing shoot. The bud scales protect this meristematic tissue until it is time to break dormancy and grow through another season.

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your family's financial needs, because your family could be earning less real interest than you expected on your insurance benefits—creating a need for more benefits.

9) **Contribute to your 401(k) plan.** If a plan is available where you work, participate. There are many tax advantages and your employer may match a portion of the money you contribute. That's hard to beat.

10) **Invest regularly.** Whether you have a 401(k) or not, you should save regularly. Look for investments that offer automatic transfers from your bank account every month. This will help keep you on the savings track.